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(54) MULTISTATION TRANSMITTING METHOD AND RECEIVER THEREFOR

**ÜBERTRAGUNGSVERFAHREN MIT MEHREREN STATIONEN UND EMPFÄNGER DAFÜR
PROCEDE DE TRANSMISSION MULTISTATION ET RECEPTEUR UTILISE A CET EFFET**

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(56) References cited:
WO-A-83/01878 JP-A- 1 288 023
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Description**TECHNICAL FIELD**

[0001] The present invention relates to a multi-station transmission method which is used in a mobile communication system and a broadcasting system to transmit the same signal from a plurality of stations with a view to holding the continuity of a signal in the vicinity of the zone boundary, and the invention also pertains to a receiver therefor.

[0002] In radio communication, especially in mobile communication, it is necessary to implement many channels in a limited frequency band; hence, the spatial reuse of frequency is an important technique. For example, a cellular system has been employed in the mobile communication. In the cellular system, the service area is divided into a plurality of cells, i.e., zones, and different frequencies are assigned to the cells to prevent interference between them, but in a bid to promote the spatial reuse of frequency, it is customary to assign the same frequency to cells at a distance long enough not to interfere with each other. Such a cellular system requires a handoff capability which enables the mobile station to keep up conversation when it moves from one cell to another, that is, from one zone to another.

[0003] Fig. 1 shows the principles of a conventional zone switching scheme. Let it be assumed that zones Z1 and Z2 covered by base stations BS1 and BS2 are adjacent and that a mobile station M is now moving across the boundary of the zones Z1 and Z2 in a direction from the base station BS1 toward the base station BS2. Forward signals to be sent from the base stations BS1 and BS2 to the mobile station M are transmitted from a switching center 13 to the two base stations BS1 and BS2 which are switched from the one to the other. A forward radio channel to the mobile station M is set first to a first channel CH1 via the base station BS1. When the field intensity of the first channel CH1 decreases with the movement of the mobile station M, a second channel CH2 is set as the forward radio channel via the base station BS2, while at the same time the first channel CH1 is cut off. Since an access channel is usually set up by FDMA (Frequency Division Multiple Access) or TDMA (Time Division Multiple Access) scheme, the same channel cannot be used in adjacent zones. Hence, the two channels CH1 and CH2 use different carrier frequencies. On this account, switching of the channels from one to the other, inevitably results in a momentary interruption during switching. In voice communication this interruption can be made sufficiently short to such an extent as not to seriously affect the speech quality, but in multimedia transmission such as video or data communication the momentary interruption causes significant quality deterioration because of high-speed transmission of digital signals in many cases.

[0004] On the other hand, in the zone switching by a

CDMA (Code Division Multiple Access) scheme, such as disclosed in JP-A-1-288023 and US-A-5,179,571, a spreading code is used for channel setting and the same carrier frequency is used in common for adjacent zones.

Then, when a multi-station transmission is carried out using different spreading codes for the adjacent zones, signals from two base stations can easily be received and interruption-free reception is possible.

[0005] However, this method is inherent to the CDMA scheme and cannot be applied to the FDMA and TDMA schemes. Furthermore, to identify a respective channel defined by the spreading code, it is necessary to use a different spreading code for each channel. There is another method (EP-A-0 620 658, prior art according to Art.54(3) EPC) which, instead of changing the spreading code, shifts its timing to avoid overlapping of pulses detected by the two inverse transformation detectors for descrambling of the two base stations, but highly accurate transmission timing must be provided between the base stations.

[0006] On the other hand, a forward control signal in the mobile communication system needs to call up mobile stations over a wide area. To cover a wide area with a low transmission output, a multi-station transmission system is needed which divides the area into a plurality of zones and transmits the same signal to the respective zones.

[0007] In the multi-station transmission system, even if the same signals are transmitted from the respective zones, they do not completely match in terms of transmission carrier frequency and transmission data timing, posing a problem that the signals from the plurality of zones interfere with each other at the boundary between the zones. To solve this problem, frequency offset type transmitter diversity or the like has been employed. This method is one that offsets the transmitter carrier frequency of each zone in the range of from 1/2 to 1/4 of the modulation band and receives the frequency offset signals by a differential detector at the receiving side, thus enabling a diversity reception. However, this method has disadvantages in that if the data timing is not the same, interference will occur and that the frequency offsetting enlarges the receiving band width correspondingly, making it hard to implement a narrow-band communication.

[0008] The document JP 4-79615 discloses to a data signal receiver which is adapted to use soft-decision for decoding error correction codes in a data signal receiving system which utilizes both a maximum likelihood estimation equalizer and error correction codes so that high accuracy error correction is effected on data signals on a transmission path with inter-code interference, such as in a multi-path environment.

[0009] An object of the present invention is to provide a multistation transmission method and a receiver therefor which, regardless of the access scheme used, allow zone switching free from signal discontinuity and enable simultaneous reception of identical signals from a plu-

ality of base stations without widening the receiving band, thereby implementing highly reliable reception based on the diversity effect.

DISCLOSURE OF THE INVENTION

[0010] This object is achieved with a method as claimed in claim 1 and a receiver as claimed in claim 8, respectively. Preferred embodiments of the invention are subject-matter of the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

- Fig. 1 is a block diagram showing the principles of a conventional zone switching scheme;
- Fig. 2 is a block diagram illustrating the transmitting side in an embodiment of the present invention;
- Fig. 3A is a diagram showing the construction of a signal transformation part 14 in Fig. 2 when it is implemented by an interleave scheme using memories;
- Fig. 3B is a diagram showing the construction of the signal transformation part 14 when it is implemented by a scramble scheme;
- Fig. 4 is a diagram showing the frame configuration of a transmission signal;
- Fig. 5 is a block diagram of the receiving side in an embodiment of the present invention;
- Fig. 6A is a block diagram of a nonlinear interference canceller forming the principal part of a signal separation part; and
- Fig. 6B is a block diagram illustrating a linear interference canceller.

BEST MODE FOR CARRYING OUT THE INVENTION

[0012] In Fig. 2 there is illustrated the base station side of an embodiment according to the present invention. At the base station side, a forward signal sequence (input signal) DI destined for a mobile station M is input into a signal transformation part 14 from a switching center 13. The forward signal sequence DI is transformed by the signal transformation part 14 into two different transmission signal sequences T1 and T2. This transformation is intended to enable the two transmission signal sequences T1 and T2 to be regarded as statistically independent (i.e., orthogonal or pseudo-orthogonal) signal sequences which have substantially

zero cross-correlation of ± 10 symbols or so; this is done by interleaves of different sizes, for example. The transformation by interleaving is performed, as schematically shown in Fig. 3A, by writing the forward signal sequence DI into memories 14M1 and 14M2 of different sizes in the row direction as indicated by the broken line arrows and then reading out the memories 14M1 and 14M2 in the column direction as indicated by the full-line arrows. By using memories of the same size but different in the length-to-width ratio, the interleaved signal sequences T1 and T2 becomes pseudo-orthogonal. Moreover, even if a burst-like error is induced on the transmission line, it is dispersed when the original signal sequence is restored by inverse transformation; hence, error correction is effectively made. Alternatively, the forward signal sequence DI may be divided into two transmission signal sequences T1 and T2 one of which is interleaved but the other of which is not.

[0013] Another method of generating signal sequences of substantially zero cross-correlation is shown in Fig. 3B, in which the transmission signal sequences T1 and T2 are generated by scrambling the forward signal sequence DI in scramblers 14S1 and 14S2 with different scramble codes SC1 and SC2 from scramble code generating parts 14C1 and 14C2. Also in this case, only one of the transmission signal sequences T1 and T2 may be formed by a scrambled version of the forward signal sequence DI. Incidentally, the signal transformation part 14 may be provided in the switching center 13, or its respective components may be provided in the corresponding base stations BS1 and BS2, or it may be provided singly. According to the present invention, as referred to later on, training signals that are added to each frame in the base stations BS1 and BS2 need only to be at least orthogonal to each other and the signal transformation part 14 may be omitted. In such an instance, the forward signal sequence DI is applied to framing circuits FR1 and FR2 of the base stations BS1 and BS2. The signal transformation part 14 may add an error correcting code to each transmission signal sequence, if necessary.

[0014] These transmission signal sequences T1 and T2 are sent to the base stations BS1 and BS2 in adjacent zones Z1 and Z2, respectively. In the base stations BS1 and BS2, the transmission signal sequences T1 and T2 are converted by framing circuits FR1 and FR2 to framed signal sequences F1 and F2, respectively. In the present invention, as shown in Fig. 4, different training signals TRN1 and TRN2 peculiar to the respective base station, which are held in registers RG1 and RG2 in the base stations BS1 and BS2, are added to transmission data DATA (the transmission signal sequences T1 and T2) of a fixed length to form respective frames. The training signals TRN1 and TRN2 used are those which are orthogonal or pseudo-orthogonal to each other, that is, signals such that the sum of multiplied values of corresponding symbols of the training signals TRN1 and TRN2 is substantially zero.

[0015] By using such signals of excellent orthogonality as the training signals TRN1 and TRN2, it is possible to increase the accuracy of coefficient setting (setting of a tap coefficient or setting of a weight coefficient) which is accompanied by correlation processing in a signal separation part 20 in Fig. 5 described later on. In the case where inter-symbol interference occurs owing to a delay time dispersion in a multi-path propagation path, however, equalization processing is involved in the signal separation part 20, hence respective multi-path components must be separated. To meet this requirement, the training signals TRN1 and TRN2 need to be excellent in autocorrelation characteristic as well as in orthogonality. That is, the autocorrelation function of each of the training signals TRN1 and TRN2 may preferably be a function which has a sharp peak at a position corresponding to a time difference 0 (a phase difference 0) but becomes negligibly small in other regions. The training signals of excellent auto-correction can be used as signals for timing regeneration. Since the above-said two characteristics, that is, the orthogonality and the auto-correction property, influence each other, it is desirable to optimize them in the system employing the present invention.

[0016] The framed signal sequences F1 and F2 generated by the framing circuits FR1 and FR2 in Fig. 2 are converted by transmitters TR1 and TR2 to modulated waves C1 and C2, respectively, which are transmitted via transmitting antennas ANT-T1 and ANT-T2. Let it be assumed that the two modulated waves C1 and C2 use the same channel selected from a channel group of FD-MA, TDMA and CDMA schemes. Furthermore, suppose that the transmitting antennas ANT-T1 and ANT-T2 are so distant from each other that when the two modulated waves C1 and C2 are received by the mobile station M, their variations by radio wave propagation can be sufficiently independent of each other.

[0017] Fig. 5 is a block diagram illustrating the construction of each mobile station M. The mobile station M simultaneously receives the modulated waves C1 and C2 of the same channel as their combined wave by a receiving antenna ANT-R. The received signal is demodulated by a receiver 19R and the resulting base band signal is outputted therefrom as a digital signal. The base band signal is applied to a signal separation part 20 wherein it is amplified and then separated into received signal sequences R1 and R2 corresponding to the modulated waves C1 and C2. This separation uses the training signals contained in each modulated wave, and the separation can be carried out using the technique of what is called an interference canceller. The interference canceller schemes can be classified into a nonlinear interference canceller and a linear interference canceller. When only one receiving antenna ANT-R is used as in the case of Fig. 5, only the nonlinear interference canceller is applicable. When two or more receiving antennas are used, either of the nonlinear and linear interference cancellers can be used.

[0018] The operation of the linear interference canceller is disclosed in detail in R. T. Compton, Jr., "Adaptive Antennas, Concept and Performance", Prentice-Hall, 1988 or Suzuki, "Signal Transmission Characteristics in Least Square Combining Diversity Reception", Journal of the Institute of Electronics, Information and Communication Engineers of Japan, B-II, vol. J75-B-II, No. 8, pp. 524-534, August, 1992; the operation of the nonlinear interference canceller is described in detail in Hitoshi Yoshino and Hiroshi Suzuki, "Adaptive Interference Canceller Extended from RLS-MLSE", Technical Report of the Institute of Electronics, Information and Communication Engineers of Japan, Technical Report RCS92-120 (1993-01). In either case, received signals from a predetermined number of base stations which can be predicted are separated into individual received signals, the received signals except a noted desired received signal are regarded as interference signals, and these separated interference signals are subtracted from the received signals of the combined received wave, by which the background noise of the desired received signal is remarkably reduced. The present invention separates all the received signals by similar processing, regarding the individual received signals as desired received signals.

[0019] The separated received signal sequences R1 and R2 are provided to inverse transformation circuits 31 and 32, wherein they are subjected to the inverse of the transformation processing shown in Fig. 3A or 3B, by which transmitted signal sequences SR1 and SR2 are obtained. The transmitted signal sequences SR1 and SR2 are fed to a signal reconstruction part 33, which selects one of the received signal sequences on the basis of likelihood values M1' and M2' corresponding to estimated errors obtained in the signal separation processing in the signal separation part 20 and outputs the selected signal sequence to an output terminal OUT.

[0020] Next, a description will be given of an example of the basic configuration of the interference canceller in the signal separation part 20. Fig. 6A is a block diagram of the non-linear interference canceller and Fig. 6B a block diagram of the linear interference canceller. In the nonlinear interference canceller of Fig. 6A, a sample value $Y(n)$ of the base band signal, obtained by the detection of the combined wave of the two modulated waves C1 and C2 by the receiver 19R, is provided as an input signal to an input terminal 2T. On the other hand, upon each application of the input signal $Y(n)$ to the input terminal 2T, a maximum likelihood sequence estimator 24 generates two signal sequence candidates (code sequence candidates) CSC1 and CSC2 each having a predetermined number of signal transitions and provides them to replica generators 22R1 and 22R2. The replica generators 22R1 and 22R2 are formed by transversal filters to which parameters for estimating the channel characteristics of the modulated waves C1 and C2, that is, impulse responses H1 and H2 of respective channels, are provided as tap coeffi-

cients; the replica generators generate estimated signals or replicas RP1 and RP2 by inner product calculations (convoluting calculations) of the signal sequence candidates CSC1 and CSC2 and the tap coefficients H1 and H2.

[0021] These replicas RP1 and RP2 are provided to subtractors 21A1 and 21A2, wherein they are subtracted from the input signal $Y(n)$ to obtain an estimation error e ; this processing is repeated for all candidates of the two signal sequences. As a result, two code sequence candidates, for which the square $|e|^2$ of the estimation error calculated by a metric calculation part 23, are determined as two most likely code sequences and estimated received signal sequences R1 and R2 are provided to output terminals on the basis of such code sequences. At the same time, metrics M1 and M2 of the code sequences are calculated from the estimation error e and are outputted. The maximum likelihood sequence estimation method is described in the aforementioned literatures and is disclosed in detail in PCT Application Publication W094/17600 (published August 4, 1994) as well. For example, the Viterbi algorithm may be used as one of the maximum likelihood sequence estimation algorithms.

[0022] The mobile station M (Fig. 2) holds in registers 27G1 and 27G2 training signal patterns TRN1 and TRN2 of the visited zone Z1 and the adjacent zone Z2 received from the base station BS1 via a control channel. Alternatively, the mobile station M prestores, as a table in a memory, the training signal patterns TRN1, TRN2, ... corresponding to identification numbers assigned to the zones Z1, Z2, ..., in which case the training signal patterns are read out from the table by use of the identification numbers of the zone Z1 and the adjacent zone Z2 received via the control channel from the base station of the visited zone Z1 and are set in the registers 27G1 and 27G2. During the reception of the training signals TRN1 and TRN2 in each frame by the receiver 19R of the mobile station M, the respective training signal patterns TRN1 and TRN2 are provided from the registers 27G1 and 27G2 to the channel parameter estimation part 25 and the replica generators 22R1 and 22R2 via switches 26S1 and 26S2.

[0023] The replica generators 22R1 and 22R2 are controlled by the tap coefficients H1 and H2 provided thereto to generate replicas (estimated received signal training signals) of the received signals from the training signal patterns TRN1 and TRN2 and provide the replicas to the subtractors 21A1 and 21A2. The parameter estimation part 25 determines, for example, by an adaptive algorithm, the tap coefficients H1 and H2 for the training patterns TRN1 and TRN2 in such a manner as to minimize the power $|e|^2$ of the estimation error signal. The replica generators (transversal filters) 22R1 and 22R2, supplied with such tap coefficients H1 and H2, are regarded as simulating the characteristic (impulse response) of the channels over which the modulated signals C1 and C2 propagate, respectively. During the

reception of the data DATA in the received frame, the tap coefficients H1 and H2 determined as mentioned above are provided to the replica generators 22R1 and 22R2 and the maximum likelihood sequence estimator 24 makes a maximum estimation of a pair of transmitted signal sequences (transmitted data) as described previously. Furthermore, the maximum likelihood sequence estimator calculates and outputs the metrics (the reliability of the estimated signal sequences) M1 and M2 of the decision paths from the likelihood ($1/|e|^2$, for example) used for the decision of the received signal sequences R1 and R2 by a known method. When the input signal sequence is transformed in the signal transformation part 14 to the transmission signal sequences T1 and T2 which are pseudo-orthogonal to each other as depicted in Fig. 2, the tap coefficients H1 and H2 can be corrected, as required, in the above-described fashion to minimize the estimation error power $|e|^2$ again through utilization of the two decided transmitted signal sequences during the data DATA receiving period. In the example of Fig. 6A, the metrics M1 and M2 have the same value. While in the above the operation by a single branch has been described, the configuration of diversity reception is also possible, in which case, too, the interference canceller similarly operates.

[0024] Fig. 6B shows the case where the signal separation part 20 is formed by the linear interference canceller. In this instance, combined received waves received by two receiving antennas ANT-R1 and ANT-R2 are converted by receivers 19R1 and 19R2 to base band signals Y1 and Y2, respectively, which are applied to input terminals 2T1 and 2T2 of the signal separation part 20. These base band signals Y1 and Y2 are weighted with weighting factors W11 and W12 in weighting circuits 21W11 and 21W12, respectively, and are added together in an adder circuit 22A1, the output of which is provided as an estimated signal for the one transmitted modulated signal C1. The estimated signal output is fed to a decision circuit 24D1, wherein it is decided to be larger or smaller than a threshold value and from which it is provided as the received signal sequence R1 to an output terminal. The difference (an estimation error) between the input and the output signal of the decision circuit 24D1 is detected by a difference circuit 23E1 and is outputted as the metric signal M1.

[0025] During the period of receiving the training signals in the transmitted frame, the training signal pattern TRN1 is provided, as a substitute for the decided output, to the difference circuit 23E1 from the register 27G1 via the switch 26S1 and a control circuit 25C1 determines the weighting factors W11 and W12 in such a manner as to minimize the square $|e|$ of the absolute value of the difference. The thus determined factors W11 and W12 are used to perform a weighted addition of the received signals Y1 and Y2 during the period of receiving the data in the transmitted frame, by which the estimated received signal sequence R1 can be obtained. The reason for which the difference output from the difference circuit

23E1, that is, the error component ϵ , becomes small is that the modulated wave C2 is cancelled.

[0026] Similarly, the signals Y1 and Y2 from the input terminals 2T1 and 2T2 are weighted by weighting circuits 21W21 and 21W22, respectively, and are added together by an adder circuit 22A2, and the added output is subjected to a level decision by a decision circuit 24D2. In the training signal receiving period the training signal pattern TRN2 from the register 27G2 is provided via the switch 26S2 to a difference circuit 23E2, by which the difference between the training signal pattern and the output from the adder circuit 22A2 is obtained. The weighting factors W21 and W22 are determined by a control circuit 25C2 so that the difference becomes minimum. By performing a weighted addition of the input signals Y1 and Y2 through use of such weighting factors during the period of receiving the data DATA in the received frame, the modulated wave C1 is cancelled and the received signal sequence R2 is outputted. In the example of Fig. 6B the metric signals M1 and M2 differ from each other. It is also possible that the sum of squares of the two metric signals M1 and M2 is distributed as a common metric signal as in the Fig. 6A example.

[0027] Thus, during the reception of the training signals the tap coefficients H1 and H2 are correctly set by the channel parameter estimation part 25 in Fig. 6A, or in Fig. 6B the weighting factors W11, W12, W21 and W22 are correctly determined.

[0028] In the interference cancellers of Figs. 6A and 6B, when the one modulated wave, for example C1, is extracted, the other modulated wave C2 is handled as an interference wave--by this, the demodulated received signal sequences R1 and R2 corresponding to the transmission signal sequences T1 and T2 contained in the respective modulated wave are extracted. The thus extracted received signal sequences R1 and R2 are provided to the inverse transformation circuits 31 and 32, wherein they are subjected to an inverse transformation, i.e., a transform that is inverse to that in the signal transformation part 14 (Fig. 2) at the transmitting side; thus, the transmitted signal sequences SR1 and SR2 are generated. When the signal transformation part 14 at the transmitting side carries out such interleave as shown in Fig. 3A, two memories of different sizes, similar to those in Fig. 3A, are provided in the inverse transformation circuits 31 and 32, respectively, and are configured so that the received signal sequences R1 and R2 are written in the column direction and read out in the row direction, just opposite in direction from that in Fig. 3A. When the transmitting side adopts the signal transformation by the scramble codes SC1 and SC2 as shown in Fig. 3B, descramblers are provided in the inverse transformation circuits 31 and 32 to descramble the received signal sequences R1 and R2 with the scramble codes SC1 and SC2.

[0029] The metric signals M1 and M2 representing the reliability of the signal sequences at the time of their sep-

aration, which are provided from the interference canceller in the signal separation part 20, are outputted in synchronization with the transmitted signal sequences SR1 and SR2. The metric is expressed by level or the inverse $1/|\epsilon|$ of the estimation error in the separation processing or its -square or negative $-|\epsilon|$ or $-|\epsilon|^2$; the larger the value, the higher the reliability. Moreover, in the inverse transformation, general metric values M1' and M2' of the transmitted signal sequences SR1 and SR2 are generated using the metric used for error correction decoding. If the transformation in the signal transformation part 14 is a mere change of the order of the interleave, the metric signals M1' and M2' obtained by the inverse transformation are signals which are merely reverse in their order compared to those of the metric signals M1 and M2. The two transmitted signal sequences SR1 and SR2 of different metrics are provided from the inverse transformation circuits 31 and 32 to the signal reconstruction part 33, which generates optimal demodulated data DO and provides it to the output terminal OUT. The demodulated data can be generated by various methods such as those (1) which selects the received signal sequence of the larger metric, (2) which weights the decided received signal sequence with the metric, then combines it with the other signal sequence and makes a decision, and (3) which performs only interleave in the inverse transformation and performs error correction decoding while selecting data of the received signal sequence of the larger metric.

[0030] The operation described above is basically the same in the handoff and the multi-station transmission system. However, the handoff has a capability of stopping signal transmission from the old zone when the intensity of the field for receiving radio waves from the new zone increases. While in the above the same signal has been described to be sent from two base stations, it may be sent from three or more base stations BS1, BS2, BS3, ... as indicated by the broken-lined base station BS3 of a third adjacent zone in Fig. 2. Letting the number of base stations be represented by N, the signal separation part 20 in Fig. 6A needs only to be provided with N subtraction circuits 21A1, 21A2, ..., N replica generators 22R1, 22R2, ..., N switches 26S1, 26S2, ..., and N registers 27G1, 27G2, In the case of the signal separation part 20 shown in Fig. 6B, N combiners 22A1, 22A2, ..., N decision circuits 24D1, 24D2, ..., N difference circuits 23E1, 23E2, ..., N control circuits 25C1, 25C2, ..., N switches 26S1, 26S2, ... and N registers 27G1, 27G2, ... are provided in association with the signals Y1, Y2, ... from N receivers 19R1, 19R2, Furthermore, N^2 weighting circuit 21W11, ..., 21WNN are provided for conducting N sets of weighted additions for the N input signals Y1, Y2,

[0031] Thus, the present invention permits zone switching through use of the same channel regardless of the access scheme used. Since no interruption occurs at the time of zone switching, the reliability of fast digital signal transmission will not be impaired. Besides,

the receiving field intensity decreases at the time of zone switching, since the mobile station usually moves near the zone boundary; according to the present invention, however, the mobile station simultaneously receives signals from a plurality of base stations this produces a diversity effect and hence improves the transmission characteristic.

[0032] Hence, the present invention is effective when applied to a high-capacity, multimedia-oriented digital mobile communications and portable telephone systems, furthermore, it is effective when dividing a wide area into a plurality of zones and performing transmission in the broadcast mode.

Claims

1. A method of transmitting the same signal via N base stations (BS1, BS2) to the same mobile station (M) of a mobile communication system in which the service area is divided into a plurality of zones each having a base station (BS1, BS2), and the mobile station (M) performs communication via the base station (BS1, BS2) of the zone it is visiting, the method comprising the step:

(a) wherein, when said mobile station (M) moves across the boundary between said visited zone and a zone adjacent to it, a forward signal sequence (DI) destined for said mobile station (M) is transmitted as a transmission signal sequence (T1, T2) to said N base stations (BS1, BS2) including the base station (BS1, BS2) of said visited zone and the base station (BS1, BS2) of said adjacent zone, N being an integer equal to or greater than 2; and is

characterized by the further steps:

(b) wherein each of said N base stations (BS1, BS2) utilizes the transmission signal sequence (T1, T2) and adds a respective one of N predetermined pseudo-orthogonal training signals (TRN1, TRN2) after each fixed length portion of said transmission signal sequence to generate a framed signal sequence (F1, F2) having in each frame a training signal period (TRN1, TRN2) and a data signal period (DATA) corresponding to the training signal and the transmission signal sequence, respectively;

(c) wherein each of said N base stations (BS1, BS2) transmits said framed signal sequence on a modulated wave (C1, C2) of a same channel; and

(d) wherein said mobile station (M) receives, as a combined wave, said modulated waves from said N base stations (BS1, BS2), produces a base band signal from the combined wave, then extracts N received signal sequences (R1, R2) from the base band signal through use of

said N training signals (TRN1, TRN2) and selects one of said N received signal sequences (R1, R2) as a reconstruction of said forward signal sequence (DI).

2. The method of claim 1, which includes

in step (a) a step of transforming said forward signal sequence (DI) by a predetermined transformation procedure into N different transmission signal sequences (T1, T2) with substantially zero cross-correlation and sending said N different transmission signal sequences (T1, T2) to said N base stations (BS1, BS2), respectively, and

in step (d) a step of obtaining N transmitted signal sequences (SR1, SR2) by subjecting said N received signal sequences (R1, R2) to an inverse transformation procedure, which is inverse to said transformation procedure in step (a), and a step of selecting one of the N transmitted signal sequences (SR1, SR2) as said reconstruction of the forward signal sequence (DI).

3. The method of claim 2, wherein said transformation procedure is a procedure of interleaving said forward signal sequence (DI) in at least (N-1) different ways to obtain said at least N different transmission signal sequences (T1, T2).

4. The method of claim 2, wherein said transformation procedure is a procedure of scrambling said forward signal sequence (DI) by at least (N-1) different scramble codes to obtain said at least N different transmission signal sequences (T1, T2).

5. The method of claim 1, wherein said step (d) comprises steps of: estimating characteristics of the transmission channels from said base stations (BS1, BS2) to said mobile station (M) through use of said N preknown training signals during the reception of said training signals in said combined wave; generating, based on said estimated transmission channel characteristics, N replicas which simulate said framed signal sequences; subtracting said N replicas from said base band signal; and making a maximum likelihood estimation in such a manner as to minimize the resulting estimation error, thereby determining said N received signal sequences (R1, R2).

6. The method of claim 1, further comprising the steps: wherein said mobile station (M) receives said combined wave of said modulated waves by each of N receivers via N different antennas to produce N base band signals, respectively; wherein N sets of weighting factors, each set composed of N weighting factors, are determined for said N training signals, so that each of N signal sequences, each obtained by respectively weighting, in the training sig-

- nal period in said combined wave, said N base band signals with the N weighting factors of a respective set and adding the weighted base band signals together, matches one of said N training signals; and wherein N output signal sequences, each obtained by weighting, in the data signal period in said combined wave, said N base band signals with said N weighting factors of a respective one of said N sets and adding the weighted base band signals together, are determined to be said N received signal sequences (R1, R2).
7. The method of claim 1, wherein said step (d) includes a step of obtaining a metric for each of said N received signal sequences (R1, R2) and a step of selecting and outputting that one of said N received signal sequences (R1, R2) that has the maximum metric.
8. A receiver for a mobile station which comprises:
- means (ANT-R, ANT-R1, ANT-R2) for receiving, as a combined wave, N modulated waves from N base stations (BS1, BS2) of N adjacent zones, N being an integer equal to or greater than 2;
- means (19R, 19R1, 19R2) for demodulating said combined wave into a base band signal, wherein the base band signal is composed of N pseudo-orthogonal signal sequences each produced in the respective base station (BS1, BS2) by adding a respective one of N predetermined pseudo-orthogonal training signals (TRN1, TRN2) after each fixed length portion of a respective one of N transmission signal sequences (T1, T2) to generate a framed signal sequence (F1, F2) having in each frame a training signal period (TRN1, TRN2) and a data signal period (DATA) corresponding to the training signal and the transmission signal sequence, respectively, and wherein said N transmission signal sequences (T1, T2) are the result of a predetermined transformation procedure transforming a forward signal sequence (DI) destined for said mobile station (M) into N different transmission signal sequences (T1, T2) with substantially zero cross-correlation;
- signal separation means (20) for extracting, by use of said N training signals, N received signal sequences (R1, R2) from the base band signal and for outputting for each received signal sequence (R1, R2) a corresponding metric indicating the reliability of that received signal sequence (R1, R2);
- inverse transformation means (31, 32) adapted to subject said N received signal sequences (R1, R2) to an inverse transformation procedure, which is the inverse of said predetermined transformation procedure, to obtain N transmitted signal sequences (SR1, SR2); and means (33) for selecting and outputting that one of said N transmitted signal sequences (SR1, SR2) as reconstruction of said forward signal sequence (DI) that has the largest metric.
9. The receiver of claim 8, wherein said signal separation means (20) comprises:
- N replica generating means (22R1, 22R2) each responsive to channel parameters to simulate the transmission channel from a respective one of said base stations (BS1, BS2) to the receiver and adapted to generate, upon each input of the base band signal, from a respective one of N signal sequence candidates (CSC1, CSC2) a replica (RP1, RP2) of a respective one of the signal sequences forming said base band signal;
- subtracting means (21A1, 21A2) for subtracting the N replicas (RP1, RP2) from said base band signal and for outputting an estimation error;
- maximum likelihood sequence estimation means (24) responsive to each input of said base band signal, for sequentially generating all signal sequence candidates (CSC1, CSC2), for calculating the likelihood for each of said candidates from said estimation error and selecting that one of said signal sequence candidates that has the maximum likelihood;
- pattern holding means (27G1, 27G2) holding said N training signals (TRN1, TRN2);
- switching means (26S1, 26S2) for applying, during the training signal periods of the signal sequences in said base band signal, said N training signals to said N replica generating means to generate replicas of the training signals used in said N base stations (BS1, BS2); and
- channel parameter generating means (25) for generating said channel parameters so that said estimation error becomes minimum.
10. The receiver of claim 8, having N antennas (ANT-R1, ANT-R2) provided at different positions and each adapted to receive the combined wave, and N RF receiving parts each connected to a respective one of the N antennas for producing a respective base band signal from the combined wave, wherein said signal separation means (20) comprises:
- N weighting and adding means (21W₁₁, 21W₁₂, 22A1; 21W₂₁, 21W₂₂, 22A2) each adapted to weight the N base band signals with a respective one of N sets of N weighting factors each

and for adding up the N weighted base band signals;

N decision means (24D1, 24D2) adapted to decide the level of the output from a respective one of said N weighting and adding means and to output one of said N received signal sequences (R1, R2);

N pattern holding means (27G1, 27G2) holding said N training signals (TRN1, TRN2), respectively;

N subtracting means (23E1, 23E2) each adapted to obtain the difference between the output from a respective one of said weighting and adding means and the training signal from a respective one of said pattern holding means during the training signal period of the signal sequences in said combined wave; and

N control means (25C1, 25C2) each adapted to determine the N weighting factors for a respective one of said N weighting and adding means that minimize said difference obtained from a corresponding one of said N subtracting means.

Patentansprüche

1. Verfahren zum Übertragen des gleichen Signals über N Basisstationen (BS1, BS2) an die gleiche Mobilstation (M) eines mobilen Telekommunikationssystems, bei dem das Anschlußgebiet in eine Vielzahl von Zonen unterteilt ist, die je eine Basisstation (BS1, BS2) haben und die Mobilstation (M) die Übermittlung über die Basisstation (BS1, BS2) der Zone durchführt, die sie besucht, wobei das Verfahren den Schritt aufweist,

(a) daß, wenn die Mobilstation (M) sich über die Grenze zwischen der besuchten Zone und einer dieser benachbarten Zone bewegt, eine für diese Mobilstation (M) bestimmte Sendesignalfolge (DI) als Übertragungssignalfolge (T1, T2) an die N Basisstationen (BS1, BS2), einschließlich der Basisstation (BS1, BS2) der besuchten Zone und der Basisstation (BS1, BS2) der benachbarten Zone übertragen wird, wobei N eine ganze Zahl gleich oder größer als zwei ist, und durch die weiteren Schritte gekennzeichnet ist,

(b) daß jede der N Basisstationen (BS1, BS2) die Übertragungssignalfolge (T1, T2) nutzt und ein jeweiliges von N vorherbestimmten pseudo-orthogonalen Übungssignalen (TRN1, TRN2) nach jedem Abschnitt fester Länge der Übertragungssignalfolge hinzufügt, um eine gerahmte Signalfolge (F1, F2) zu erzeugen, die in jedem Rahmen eine Übungsignalperiode (TRN1, TRN2) und eine Datensignalperiode

(DATA) entsprechend dem Übungssignal bzw. der Übertragungssignalfolge enthält;

(c) daß jede der N Basisstationen (BS1, BS2) die gerahmte Signalfolge auf einer modulierten Welle (C1, C2) des gleichen Kanals überträgt; und

(d) daß die Mobilstation (M) als kombinierte Welle die modulierten Wellen von den N Basisstationen (BS1, BS2) empfängt, ein Basisbandsignal aus der kombinierten Welle macht, dann die N empfangenen Signalfolgen (R1, R2) vom Basisbandsignal durch Verwendung der N Übungssignale (TRN1, TRN2) extrahiert und eine der N empfangenen Signalfolgen (R1, R2) als Rekonstruktion der Sendesignalfolge (DI) auswählt.

2. Verfahren nach Anspruch 1, welches folgendes umfaßt

im Schritt (a): einen Schritt des Umwandeln der Sendesignalfolge (DI) mittels einer vorherbestimmten Transformationsprozedur in N verschiedene Übertragungssignalfolgen (T1, T2) mit im wesentlichen Null Kreuzkorrelation und Aussenden der N verschiedenen Übertragungssignalfolgen (T1, T2) an die jeweiligen N Basisstationen (BS1, BS2), und

im Schritt (d): einen Schritt des Erhaltens von N übertragenen Signalfolgen (SR1, SR2) dadurch, daß die N empfangenen Signalfolgen (R1, R2) einer Rücktransformationsprozedur unterworfen werden, die umgekehrt zu der Transformationsprozedur im Schritt (a) ist, und einen Schritt der Auswahl einer der N übertragenen Signalfolgen (SR1, SR2) als die Rekonstruktion der Sendesignalfolge (DI).

3. Verfahren nach Anspruch 2, bei dem die Transformationsprozedur ein Verfahren des Verschachtelns der Signalfolge (DI) auf mindestens (N-1) unterschiedliche Weisen zum Erhalten der mindestens N verschiedenen Übertragungssignalfolgen (T1, T2) ist.

4. Verfahren nach Anspruch 2, bei dem die Transformationsprozedur ein Verfahren des Verwürfelns der Sendesignalfolge (DI) mittels mindestens (N-1) verschiedenen Verwürfelungscodes zum Erhalten der mindestens N verschiedenen Übertragungssignalfolgen (T1, T2) ist.

5. Verfahren nach Anspruch 1, bei dem der Schritt (d) folgende Schritte aufweist: Schätzen von Charakteristiken der Übertragungskanäle von den Basisstationen (BS1, BS2) zu der Mobilstation (M) durch Verwendung der N im voraus bekannten Übungssignale während des Empfangs der Übungssignale in der kombinierten Welle; Erzeugen von N die gerahmten Signalfolgen simulierenden Replikaten auf

der Basis der geschätzten Übertragungskanalcharakteristiken; Subtrahieren der N Replikate vom Basisbandsignal; und Vornahme einer Maximum-Likelihood-Schätzung auf solche Weise, daß der erhaltene Schätzfehler minimiert wird, wodurch die N empfangenen Signalfolgen (R1, R2) bestimmt werden.

6. Verfahren nach Anspruch 1, ferner mit den folgenden Schritten: daß die Mobilstation (M) die kombinierte Welle der modulierten Wellen durch jeden von N Empfängern über N verschiedene Antennen empfängt, um jeweilige N Basisbandsignale zu erzeugen; daß N Sätze Gewichtungsfaktoren, jeder Satz aus N Gewichtungsfaktoren zusammengesetzt, für die N Übungssignale bestimmt werden, so daß jede der N Signalfolgen, jede erhalten durch jeweilige Gewichtung der N Basisbandsignale in der Übungssignalperiode in der kombinierten Welle mit den N Gewichtungsfaktoren eines jeweiligen Satzes und Zusammenaddieren der gewichteten Basisbandsignale, mit einem der N Übungssignale übereinstimmt; und daß N Ausgabesignalfolgen, jede erhalten durch Gewichten der N Basisbandsignale in der Datensignalperiode in der kombinierten Welle mit den N Gewichtungsfaktoren eines jeweiligen der N Sätze und Zusammenaddieren der gewichteten Basisbandsignale, als die N empfangenen Signalfolgen (R1, R2) bestimmt werden.
7. Verfahren nach Anspruch 1, bei dem der Schritt (d) einen Schritt des Erhaltens einer Metrik für jede der N empfangenen Signalfolgen (R1, R2) und einen Schritt des Auswählens und Ausgebens derjenigen der N empfangenen Signalfolgen (R1, R2) umfaßt, die die maximale Metrik hat.
8. Empfänger für eine Mobilstation, aufweisend:
 - eine Einrichtung (ANT-R, ANT-R1, ANT-R2) zum Empfang N modulierter Wellen von N Basisstationen (BS1, BS2) von N benachbarten Zonen als eine kombinierte Welle, wobei N eine ganze Zahl gleich oder größer als 2 ist;
 - eine Einrichtung (19R, 19R1, 19R2) zum Demodulieren der kombinierten Welle in ein Basisbandsignal, bei dem das Basisbandsignal aus N pseudo-orthogonalen Signalfolgen zusammengesetzt ist, von denen jede in der jeweiligen Basisstation (BS1, BS2) geschaffen ist durch Addieren eines jeweiligen von N vorherbestimmten pseudo-orthogonalen Übungssignalen (TRN1, TRN2) nach jedem Abschnitt fester Länge einer jeweiligen von N Übertragungssignalfolgen (T1, T2) zum Erzeugen einer gerahmten Signalfolge (F1, F2), die in jedem Rahmen eine Übungssignalperiode (TRN1, TRN2) und eine Datensignalperiode

(DATA) entsprechend dem Übungssignal bzw. der Übertragungssignalfolge hat, und bei der die N Übertragungssignalfolgen (T1, T2) das Ergebnis einer vorherbestimmten Transformationsprozedur sind, die eine für die Mobilstation (M) bestimmte Sendesignalfolge (D1) in N verschiedene Übertragungssignalfolgen (T1, T2) mit im wesentlichen Null Kreuzkorrelation umwandelt;

eine Signaltrenneinrichtung (20) zum Extrahieren von N empfangenen Signalfolgen (R1, R2) aus dem Basisbandsignal durch Benutzen der N Übungssignale und zum Ausgeben für jede empfangene Signalfolge (R1, R2) einer entsprechenden, die Zuverlässigkeit der empfangenen Signalfolge (R1, R2) anzeigenden Metrik;

eine Rückumwandlungseinrichtung (31, 32), die geeignet ist, die N empfangenen Signalfolgen (R1, R2) einer Rücktransformationsprozedur zu unterwerfen, die das Umgekehrte der vorherbestimmten Transformationsprozedur ist, um die N übertragenen Signalfolgen (SR1, SR2) zu erhalten; und

eine Einrichtung (33) zum Auswählen und Ausgeben derjenigen der N übertragenen Signalfolgen (SR1, SR2), als Rekonstruktion der Sendesignalfolge (D1), die die größte Metrik hat.

9. Empfänger nach Anspruch 8, bei dem die Signaltrenneinrichtung (20) folgendes aufweist:

N Replica-Generatoreinrichtungen (22R1, 22R2), von denen jede auf Kanalparameter anspricht, um den Übertragungskanal von einer jeweiligen der Basisstationen (BS1, BS2) zum Empfänger zu simulieren, und geeignet ist, bei jeder Eingabe des Basisbandsignals von einem entsprechenden von N Signalfolgekandidaten (CSC1, CSC2) ein Replikat (RP1, RP2) einer jeweiligen der das Basisbandsignal bildenden Signalfolgen zu erzeugen;

eine Subtraktionseinrichtung (21A1, 21A2) zum Subtrahieren der N Replikate (RP1, RP2) von dem Basisbandsignal und zum Ausgeben eines Schätzfehlers;

eine Maximum-Likelihood-Folge-Schätzeinrichtung (24), die auf jede Eingabe des Basisbandsignals anspricht, um der Reihe nach alle Signalfolgekandidaten (CSC1, CSC2) zu erzeugen, um die Wahrscheinlichkeit für jeden der Kandidaten aus dem Schätzfehler zu berechnen und denjenigen der Signalfolgekandidaten auszuwählen, der die größte Wahrscheinlichkeit hat;

eine Musterhalteeinrichtung (27G1, 27G2), die die N Übungssignale (TRN1, TRN2) hält;

eine Schaltereinrichtung (26S1, 26S2), die

während der Übungssignalperioden der Signalfolgen im Basisbandsignal die N Übungssignale an die N Replica-Generatoreinrichtung anlegt, um Replikate der in den N Basisstationen (BS1, BS2) benutzten Übungssignale zu erzeugen; und

eine Kanalparametergeneratoreinrichtung (25) zum Erzeugen der Kanalparameter, so daß der Schätzfehler minimal wird.

10. Empfänger nach Anspruch 8, mit N Antennen (ANT-R1, ANT-R2), die an verschiedenen Positionen vorgesehen sind und von denen jede geeignet ist, die kombinierte Welle zu empfangen, und N RF-Empfangsteilen, von denen jeder mit einer jeweiligen der N Antennen verbunden ist, um ein jeweiliges Basisbandsignal aus der kombinierten Welle zu schaffen, wobei die Signaltrenneinrichtung (20) folgendes aufweist:

N Gewichtungs- und Addiereinrichtungen ($21W_{11}$, $21W_{12}$, $22A1$; $21W_{21}$, $21W_{22}$, $22A2$), von denen jede geeignet ist, die N Basisbandsignale mit einem jeweiligen von N Sätzen aus je N Gewichtungsfaktoren zu gewichten und zum Zusammenaddieren der N gewichteten Basisbandsignale;

N Entscheidungseinrichtungen ($24D1$, $24D2$), die geeignet sind, das Niveau der Ausgabe von einer jeweiligen der N Gewichtungs- und Addiereinrichtungen zu entscheiden und eine der N empfangenen Signalfolgen (R1, R2) auszugeben;

N Musterhalteeinrichtungen ($27G1$, $27G2$), welche jeweils die N Übungssignale (TRN1, TRN2) halten;

N Subtrahiereinrichtungen ($23E1$, $23E2$), von denen jede geeignet ist, die Differenz zwischen der Ausgabe einer jeweiligen der Gewichtungs- und Addiereinrichtungen und dem Übungssignal von einer jeweiligen der Musterhalteeinrichtungen während der Übungssignalperiode der Signalfolgen in der kombinierten Welle zu erhalten; und

N Steuereinrichtungen ($25C1$, $25C2$), von denen jede geeignet ist, die N Gewichtungsfaktoren für eine jeweilige der N Gewichtungs- und Addiereinrichtungen zu bestimmen, welche die von einer entsprechenden der N Subtrahiereinrichtungen erhaltenen Differenz minimiert.

Revendications

1. Procédé de transmission du même signal en passant par N stations de base (BS1, BS2) vers la même station mobile (M) d'un système de communications du service mobile dans lequel la zone de

service est divisée en une pluralité de zones ayant chacune une station de base (BS1, BS2), et la station mobile (M) effectue une communication en passant par la station de base (BS1, BS2) de la zone qu'elle visite, le procédé comprenant l'étape :

(a) dans laquelle, lorsque ladite station mobile (M) franchit la limite entre ladite zone visitée et une zone qui lui est adjacente, une séquence (D1) de signal d'avance destinée à ladite station mobile (M) est transmise en tant que séquence de signal de transmission (T1, T2) auxdites N stations de base (BS1, BS2) y compris la station de base (BS1, BS2) de ladite zone visitée et la station de base (BS1, BS2) de ladite zone adjacente, N étant un entier égal ou supérieur à 2 ; et est

caractérisé par les autres étapes :

(b) dans lesquelles chacune desdites N stations de base (BS1, BS2) utilise la séquence de signal de transmission (T1, T2) et additionne l'un, respectif, de N signaux d'entraînement pseudo-orthogonaux prédéterminés (TRN1, TRN2) après chaque partie de longueur fixe de ladite séquence de signal de transmission pour générer une séquence de signal tramé (F1, F2) ayant, dans chaque trame, une période de signal d'entraînement (TRN1, TRN2) et une période de signal de données (DONNEES) correspondant au signal d'entraînement et à la séquence de signal de transmission, respectivement ;

(c) dans lesquelles chacune desdites N stations de base (BS1, BS2) transmet ladite séquence de signal tramée sur une onde modulée (C1, C2) d'un même canal ; et

(d) dans lesquelles ladite station mobile (M) reçoit, en tant qu'onde combinée, lesdites ondes modulées provenant desdites N stations de base (BS1, BS2), produit un signal de bande de base à partir de l'onde combinée puis extrait N séquences de signaux reçus (R1, R2) du signal de bande de base en utilisant lesdits N signaux d'entraînement (TRN1, TRN2) et sélectionne l'une desdites N séquences de signaux reçus (R1, R2) en tant que reconstruction de ladite séquence de signal d'avance (D1).

2. Procédé selon la revendication 1, qui comprend dans l'étape (a), une étape de transformation de ladite séquence de signal d'avance (D1) par une procédure de transformation prédéterminée en N séquences de signaux de transmission différentes (T1, T2) avec une intercorrélation sensiblement nulle et d'envoi desdites N séquences de signaux de transmission différentes (T1, T2) auxdites N stations de base (BS1, BS2), respectivement, et dans l'étape (d), une étape d'obtention de N

- séquences de signaux transmis (SR1, SR2) en soumettant lesdites N séquences de signaux reçus (R1, R2) à une procédure de transformation inverse, qui est inverse de ladite procédure de transformation dans l'étape (a), et une étape de sélection de l'une des N séquences de signaux transmis (SR1, SR2) en tant que ladite reconstruction de la séquence de signal d'avance (D1).
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3. Procédé selon la revendication 2, dans lequel ladite procédure de transformation est une procédure d'entrelacement de ladite séquence de signal d'avance (D1) en au moins (N-1) manières différentes pour obtenir lesdites, au moins N, séquences des signaux de transmission différentes (T1, T2).
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4. Procédé selon la revendication 2, dans lequel ladite procédure de transformation est une procédure de cryptage de ladite séquence de signal d'avance (D1) par au moins (N-1) codes de cryptage différents pour obtenir lesdites, au moins N, séquences de signaux de transmission différentes (T1, T2).
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5. Procédé selon la revendication 1, dans lequel ladite étape (d) comprend des étapes : d'estimation de caractéristiques des canaux de transmission à partir desdites stations de base (BS1, BS2) vers ladite station mobile (M) par l'utilisation desdits N signaux d'entraînement préalablement connus pendant la réception desdits signaux d'entraînement dans ladite onde combinée ; de génération, sur la base desdites caractéristiques estimées des canaux de transmission, de N répliques qui simulent lesdites séquences de signaux tramés ; de soustraction desdites N répliques dudit signal de bande de base ; et de réalisation d'une estimation de vraisemblance maximale d'une manière telle que l'erreur d'estimation résultante est minimisée, déterminant ainsi lesdites N séquences de signaux reçus (R1, R2).
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6. Procédé selon la revendication 1, comprenant en outre les étapes : dans lesquelles ladite station mobile (M) reçoit ladite onde combinée desdites ondes modulées par chacun de N récepteurs en passant par N antennes différentes pour produire N signaux de bande de base, respectivement ; dans lesquelles N ensembles de facteurs de pondération, chaque ensemble étant composé de N facteurs de pondération, sont déterminés pour lesdits N signaux d'entraînement, afin que chacune de N séquences de signaux, obtenues chacune en pondérant respectivement, dans la période du signal d'entraînement dans ladite onde combinée, lesdits N signaux de bande de base avec les N facteurs de pondération d'un ensemble respectif et en additionnant ensemble les signaux pondérés de bande de base, soit adaptée à l'un desdits N signaux
- d'entraînement ; et dans lesquels N séquences de signaux de sortie, obtenues chacune en pondérant, dans la période de signal de données dans ladite onde combinée, lesdits N signaux de bande de base avec lesdits N facteurs de pondération de l'un, respectif, desdits N ensembles et en additionnant ensemble les signaux pondérés de bande de base, sont déterminées comme étant lesdites N séquences de signaux reçus (R1, R2).
7. Procédé selon la revendication 1, dans lequel ladite étape (d) comprend une étape d'obtention d'une métrique pour chacune desdites N séquences de signaux reçus (R1, R2) et une étape de sélection et de sortie de l'une desdites N séquences de signaux reçus (R1, R2) qui a la métrique maximale.
8. Récepteur pour une station mobile qui comporte :
- des moyens (ANT-R, ANT-RA, ANT-R2) destinés à recevoir, sous la forme d'une onde combinée, N ondes modulées provenant de N stations de base (BS1, BS2) de N zones adjacentes, N étant un entier égal ou supérieur à 2 ;
- des moyens (19R, 19R1, 19R2) destinés à démoduler ladite onde combinée en un signal de bande de base, le signal de bande de base étant composé de N séquences de signaux pseudo-orthogonales produites chacune dans la station de base respective (BS1, BS2) en additionnant l'un, respectif, de N signaux d'entraînement pseudo-orthogonaux prédéterminés (TRN1, TRN2) après chaque partie de longueur fixe de l'une, respective, de N séquences de signaux de transmission (T1, T2) pour générer une séquence de signal tramé (F1, F2) ayant, dans chaque trame, une période de signal d'entraînement (TRN1, TRN2) et une période de signal de données (DONNEES) correspondant au signal d'entraînement et à la séquence de signal de transmission, respectivement, et dans lequel lesdites N séquences de signaux de transmission (T1, T2) sont le résultat d'une procédure de transformation prédéterminée transformant une séquence de signal avant (D1) destinée à ladite station mobile (M) en N séquences de signaux de transmission différentes (T1, T2) avec une intercorrélation sensiblement nulle ;
- des moyens (20) de séparation de signaux destinés à extraire, en utilisant lesdits N signaux d'entraînement, N séquences de signaux reçus (R1, R2) à partir du signal de bande de base et à délivrer en sortie pour chaque séquence de signal reçu (R1, R2) une métrique correspondante indiquant la fiabilité de cette séquence de signal reçue (R1, R2) ;
- des moyens de transformation inverse (31, 32)

conçus pour soumettre lesdites N séquences de signaux reçus (R1, R2) à une procédure de transformation inverse, qui est l'inverse de ladite procédure de transformation prédéterminée, pour obtenir N séquences de signaux transmis (SR1, SR2) ; et
des moyens (33) destinés à sélectionner et délivrer en sortie l'une desdites N séquences de signaux transmis (SR1, SR2) en tant que reconstruction de ladite séquence de signal avant (D1) qui a la plus grande métrique.

9. Récepteur selon la revendication 8, dans lequel lesdits moyens (20) de séparation de signaux comprennent :

N moyens (22R1, 22R2) de génération de réplique réagissant chacun à des paramètres des canaux en simulant le canal de transmission de l'une, respective, desdites stations de base (BS1, BS2) au récepteur et conçus pour générer, lors de chaque entrée du signal de bande de base, à partir de l'une, respective, de N candidates de séquences de signaux (CSC1, CSC2), une réplique (RP1, RP2) de l'une, respective, des séquences de signaux formant ledit signal de bande de base ;
des moyens de soustraction (21A1, 21A2) destinés à soustraire les N répliques (RP1, RP2) dudit signal de bande de base et à délivrer en sortie une erreur d'estimation ;
des moyens (24) d'estimation de séquence de vraisemblance maximale qui, en réponse à chaque entrée dudit signal de bande de base, sont destinés à générer séquentiellement toutes les candidates de séquences de signaux (CSC1, CSC2), à calculer la vraisemblance de chacune desdites candidates à partir de ladite erreur d'estimation et à sélectionner celle, desdites candidates de séquences de signaux, qui a la vraisemblance maximale ;
des moyens (27G1, 27G2) de blocage de combinaison bloquant lesdits N signaux d'entraînement (TRN1, TRN2) ;
des moyens de commutation (26S1, 26S2) destinés à appliquer, pendant les périodes des signaux d'entraînement des séquences de signaux dans ledit signal de bande de base, lesdits N signaux d'entraînement auxdits N moyens de génération de répliques pour générer des répliques des signaux d'entraînement utilisées dans lesdites N stations de base (BS1, BS2) ; et
des moyens (25) de génération de paramètres de canaux destinés à générer lesdits paramètres de canaux afin que ladite erreur d'estimation devienne minimale.

10. Récepteur selon la revendication 8, ayant N antennes (ANT-R1, ANT-R2) prévues dans différentes positions et conçues chacune pour recevoir l'onde combinée, et N parties de réception RF connectées chacune à l'une, respective, des N antennes pour produire un signal de bande de base respectif à partir de l'onde combinée, dans lequel lesdits moyens (20) de séparation de signaux comportent :

N moyens de pondération et d'addition (21W₁₁, 21W₁₂, 22A1 ; 21W₂₁, 21W₂₂, 22A2) conçus chacun pour pondérer les N signaux de bande de base avec l'un, respectif, de N ensembles de N facteurs de pondération chacun et pour additionner les N signaux de bande de base pondérés ;
N moyens de décision (24D1, 24D2) conçus pour décider du niveau du signal de sortie de l'un, respectif, des N moyens de pondération et d'addition et pour délivrer en sortie l'une desdites N séquences de signaux reçus (R1, R2) ;
N moyens (27G1, 27G2) de blocage de combinaison bloquant lesdits N signaux d'entraînement (TRN1, TRN2), respectivement ;
N moyens de soustraction (23E1, 23E2) conçus chacun pour obtenir la différence entre le signal de sortie de l'un, respectif, desdits moyens de pondération et d'addition et le signal d'entraînement provenant de l'un, respectif, desdits moyens de blocage de combinaison pendant la période de signal d'entraînement des séquences de signaux dans ladite onde combinée ; et
N moyens de commande (25C1, 25C2) conçus chacun pour déterminer les N facteurs de pondération pour l'un, respectif, desdits N moyens de pondération et d'addition qui minimisent ladite différence obtenue à partir de l'un, correspondant, desdits N moyens de soustraction.

FIG.1

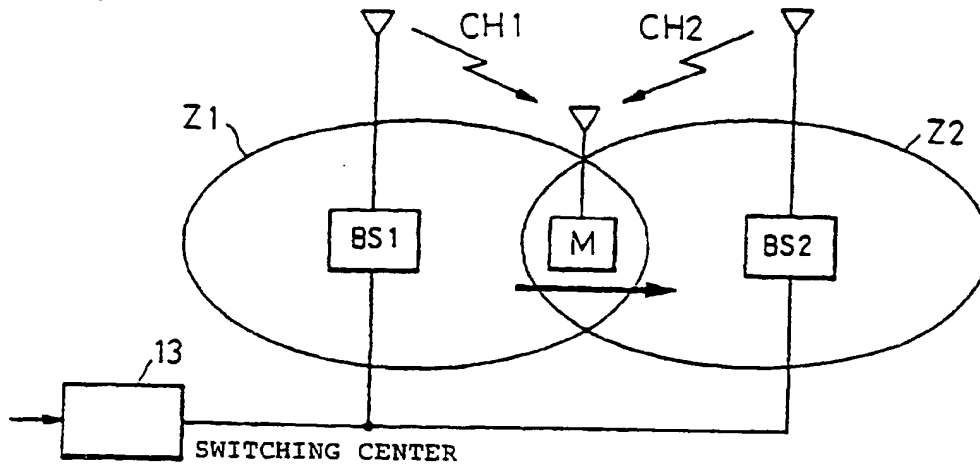


FIG.2

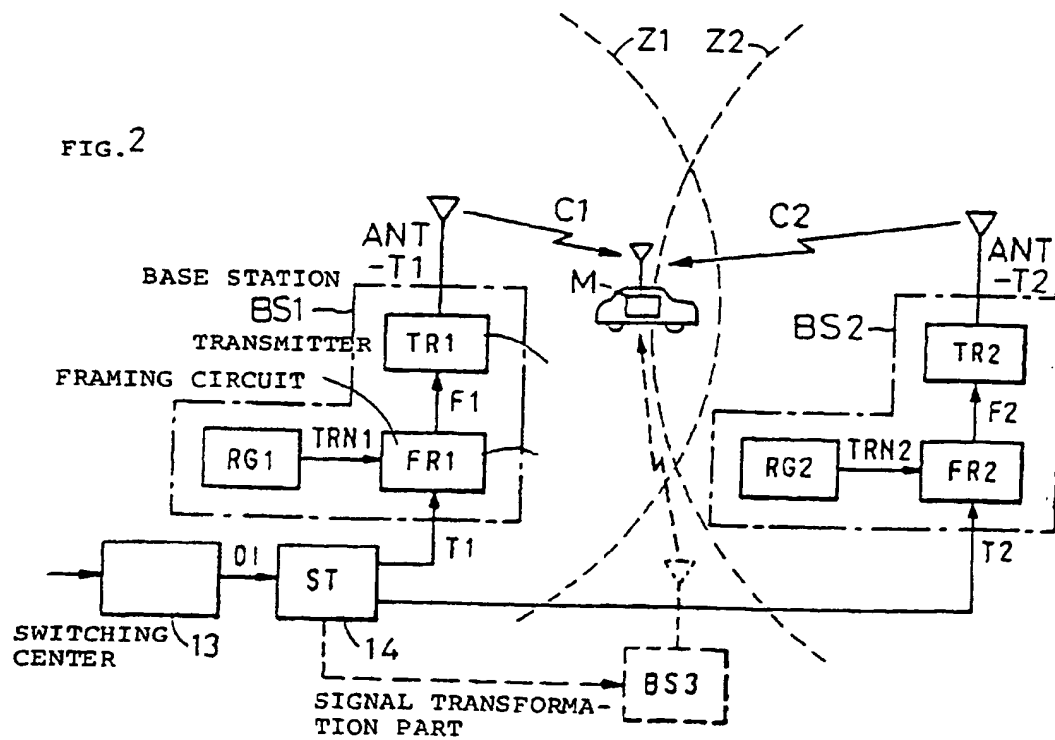


FIG. 3A

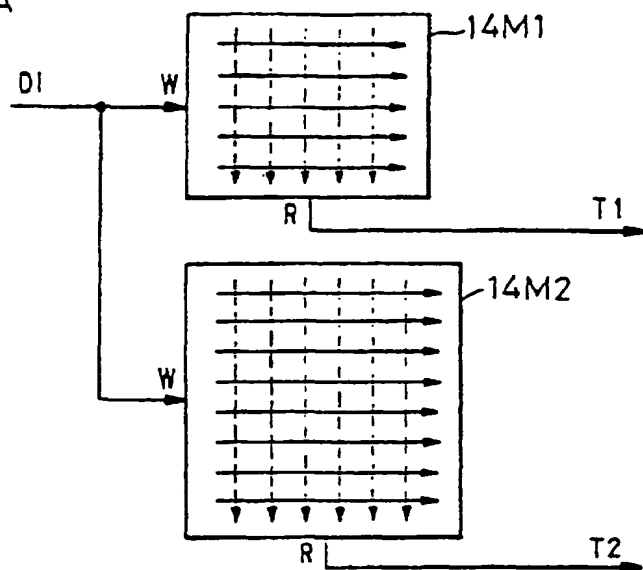


FIG. 3B

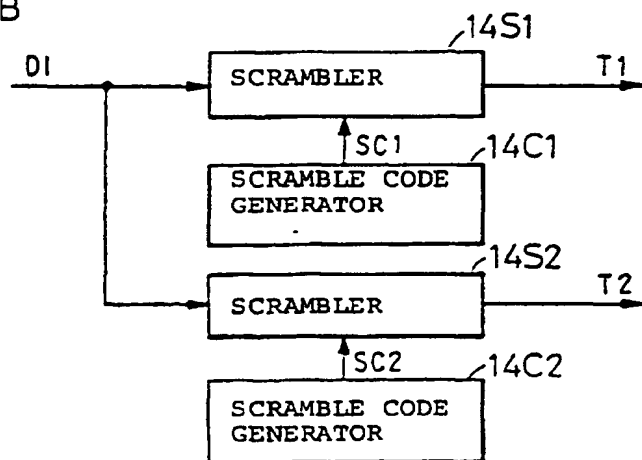


FIG. 4

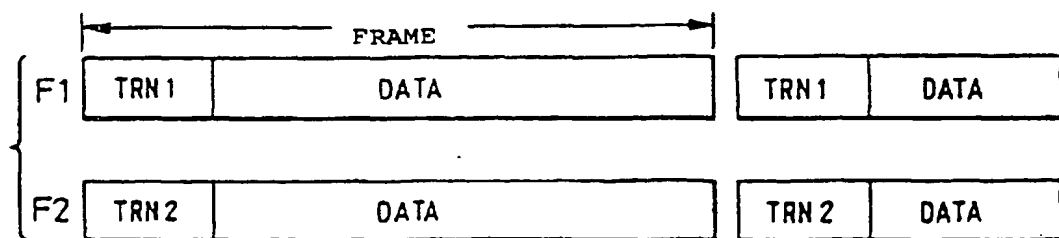


FIG. 5

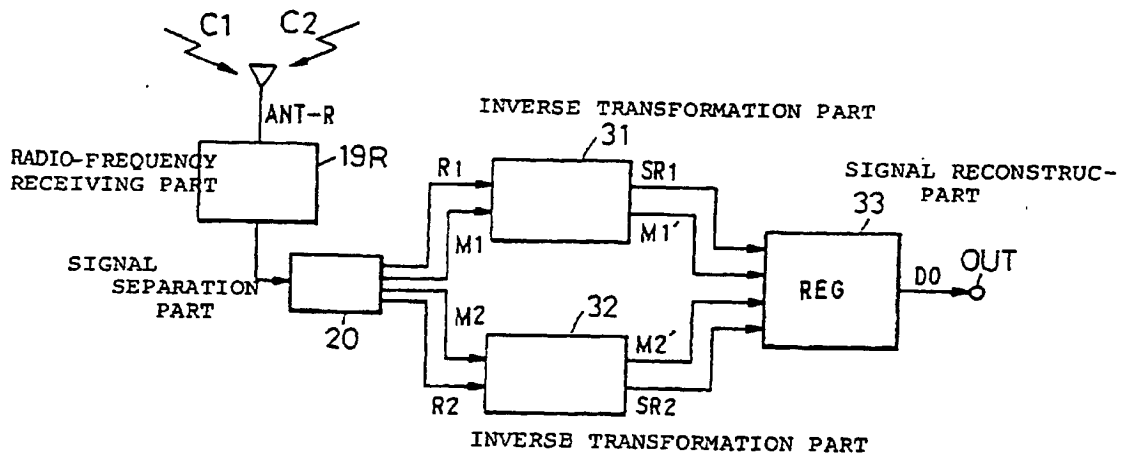
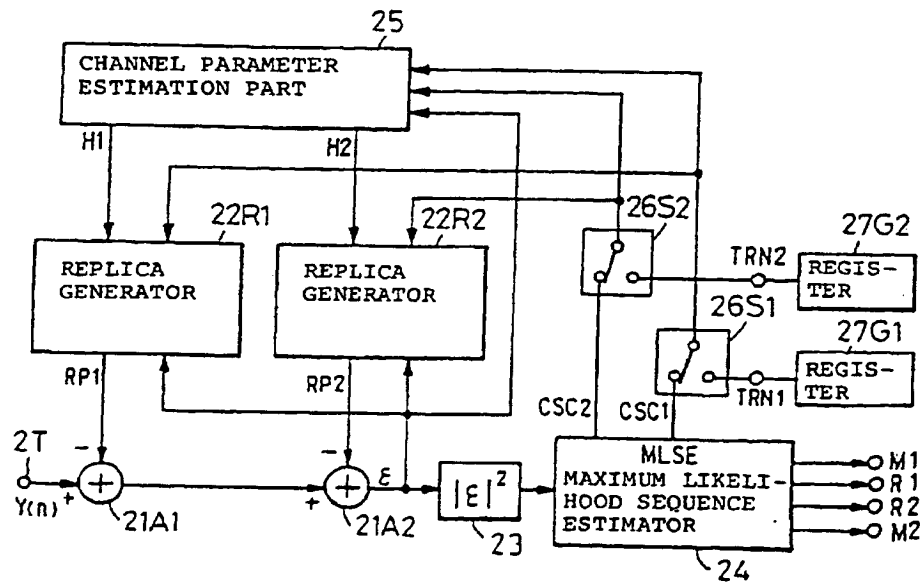
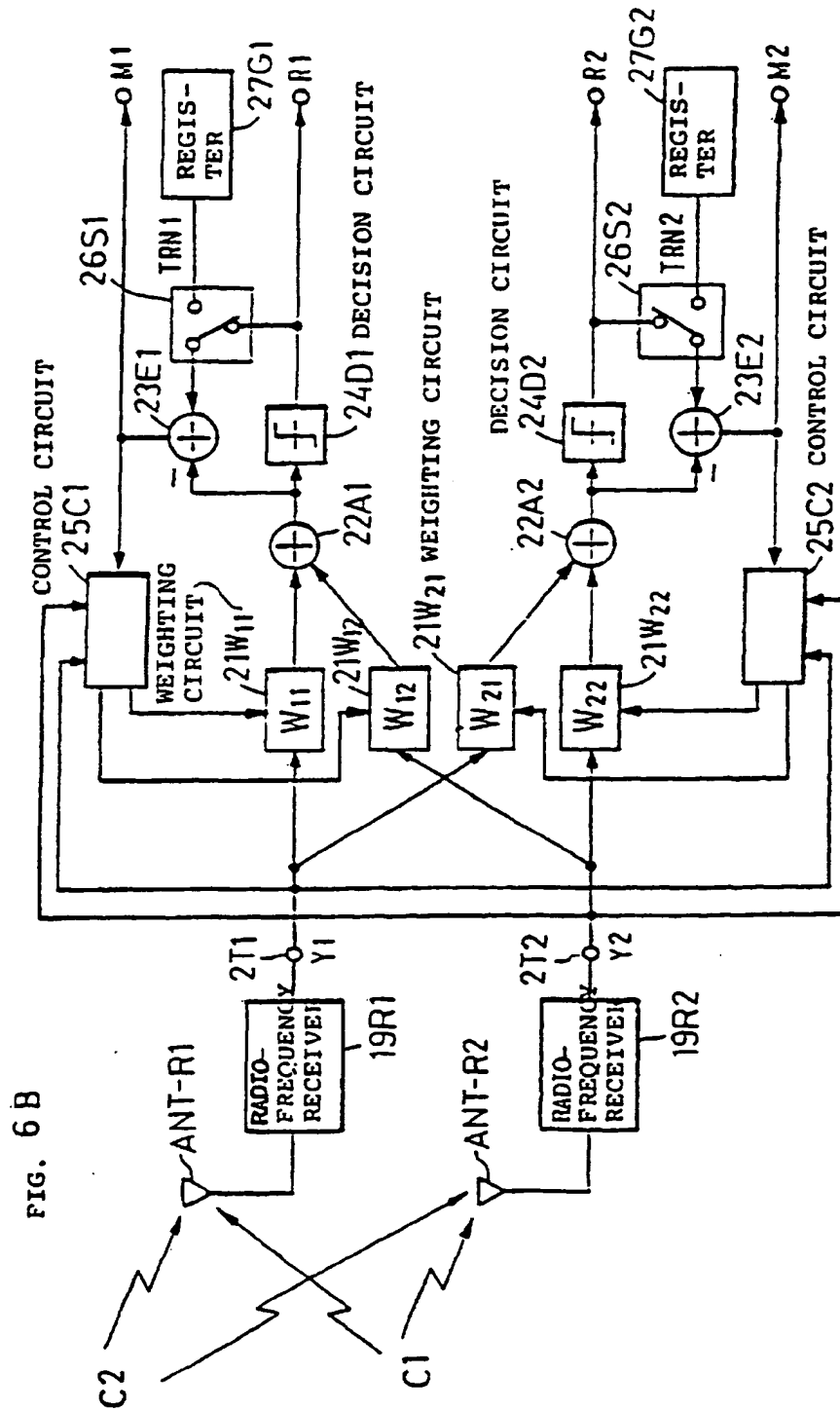


FIG. 6 A





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